JAP&T
TPA-Timişoara

Available online at http://journal-of-agroalimentary.ro

Journal of Agroalimentary Processes and Technologies 2011, *17*(4), 381-387

Journal of Agroalimentary Processes and Technologies

Potatoes paste addition influence on bread quality

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Received: 25 November 2011; Accepted: 20 December 2011

Abstract

For establishing the bread quality, a special importance shows it's chemical composition, because the substances that enter in it's constitution serve to obtaining the energy necessary to the human body. Beside the chemical composition, the bread quality and alimentary use, respectively, depends a large measure on a series of signs: flavor and taste, external appearance, crumb porosity and texture, breads' volume. This paper is part of a more complex study which has as objective to obtain some kinds of bread with high nutritive value and improving rheological properties (bread volume, structure, elasticity) by mixing dough with potatoes paste as adjuvant to substitute bakery additives. The analysis performed on bread, were: sensorial, physic-chemical analysis and a series of rheological tests (compression tests) with 30%, 50% and 70% potato paste addition, respectively. Experimental results indicated that 50% potatoes paste add was the most indicate to be used in bread processing. This hypothesis was sustained too by the data resulted from compression and relaxation tests of all samples and from correlation between compression modulus and potatoes paste containing.

Keywords: bread quality, potatoes paste, chemical composition, viscoelastic properties

1. Introduction

Bread is one of the most important human food product, being needful for daily feed for its nutritive value and for its content of energizing substances.

The healthy effect of the bread and bakery products on the health of the population is very important if we mention the variety of these products in the daily diet, starting from the cereals consumption for breakfast, to the paste, bakery and pastry products, that never miss from any consumer's meal [1,2].

On a national scale lately, a diversification of the bakery products developed by local customs, that regard products weights, shape, recipe, technologies and products flavor, but also by taking over the local consumers to some products from other countries.

In this regard, there is an intense concern for improving bread and bakery products quality, essential criteria for our country to reach the standards and demands enforced by the European Union [3,4].

Applying the proper recipes and technologies, by flour processing, as basis raw material, a large variety of products can be obtained, in order to satisfy the more increasing and more various products of the human nourishment. Different kinds of white, demi-white and black bread, simple and with addition products and dietetically products are obtained. The products differentiate in aspect, taste and way of use. These features are given either by the flour assortment used, or by the dough composition that the bread is obtained from, at the preparing of which, beside flour, water, dough strengthener and salt, there

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are used fats, sugar, milk, vegetables, eggs, fruits and flavors, too [5].

Specialists present preoccupation are related with obtaining baking products with superior quality, loosened, with pleasant taste and flavor, which have the capacity to maintain themselves fresh for a long time, with high nutritive value, but also correction on bread or bread products imperfections [6]. Also, it is well known the orientation of food producers to traditional, natural and healthy products.

Having reference to these observations, the aim of this paper was to obtain some high nutritional value bread assortments, and also the improving these rheological (texture) features, by potatoes pasta addition. In this regard, the following analysis were performed on bread: sensorial, physio-chemical analysis and a series of rheological tests (compression tests) with 30%, 50% and 70% potatoes paste addition, respectively. The use of the potatoes paste as addition in common bread preparing, is justified starting from the complex composition of these: carbohydrates (17.9%), proteins (2.1%), fats (0.1%), vitamins (A, B1, B2, C, D, PP) and microelements (potassium, phosphorus) [7, 8]. The proteins from potato tubers are ones of the most digestible vegetal proteins and are recommended for persons with protein diet. Also, because of the mineral elements high content of potato, it helps in maintaining a good equilibrium of human body acidity. They can be consumed boiled, baked or fried.The ones processed by heat develop several flavour components [7,9].

Besides nutritive substances contribution, through addition of potatoes paste in bread dough can be obtained bread with special taste and flavor and with a better shelf life [10].

The influence of potatoes paste content on rheological properties of bread crumb was studied. Rheological characterization was made by compressive loading tests [11,12,13,14].

2.Material and Method

*2.1.Bread obtaining technological process.*The technological process for potatoes paste addition bread obtaining was the common one. The recipe used, was the following one: flour 1000 g, water - 57%, yeast – 2,5%, salt – 2%, and potatoes paste addition in various amounts: 30%, 50% and 70%, respectively.

Similarly, a witness bread sample without potatoes paste addition was performed. After fermentation period, the dough was divided into two equal parts, it was modelated and baked.

The optimum parameters of the technological process were: *kneading* 20 minutes/28°C, *fermentation* 40 minutes/35°C, *baking* 5 minutes/200°C and 20 minutes/180°C.

*2.2. Preparing the potatoes paste.*The potato paste is obtained by hydro thermally processing the unpeeled raw potato for 30 minutes at water boiling temperature, then cooling it, peeling, and mashing it by passing it through the ϕ2 mm mesh sieve with mixer [15].

2.3.Potatoes paste supplemented bread quality evaluation

*2.3.1. Bread sensory analysis.*The bread obtained as we descried in pharagraph 2.1. was subjected to sensorial examination: form, crumb aspect, volume, consistency and chewing comparisson, bread aspect, smell, taste, micobiological alteration signs, foreign bodies (as *STAS 91-83*) [16,17,18].

2.3.2. Bread physic-chemical analysis. Also, the bread obtained after the above described method, was submitted to the physic-chemical exam**,** following: *the product volume, crumb porosity and elasticity, height/diameter ratio, moist and acidity (according to STAS 91-83 „ Bread, loaf products and bakery specialties. Analysis methods")* [16,17,18].

2.3.3. Bread rheological features evaluation. From the so obtained bread, a slice of about 3 cm was cut. The slice was cut after 2 hours of room temperature storage. From this slice, samples were taken with a cylinder 3 cm long and 2 cm in diameter. Further, compression tests were performed. For each bread assortment, 3 times each were performed. For the experimental study, a compression JTL Janz apparatus was used. The so obtained samples were compressed with a constant speed to 120 seconds, the compression force being read at every 5 seconds. The obtained data were interpreted in the ORIGINI 7.0. program. Two replicates were analyzed and averaged [4,13,14,19,20].

3. Results and Discussion

The potatoes paste supplemented bread quality appreciation was performed by correlating the rheological measures with sensory and physic - chemical tests taken.

*3.1. Potatoes paste supplemented bread sensory evaluation. Points scale method.*The bread obtained according to the *paragraph 2.1.*, showed the following sensory features *(table 1)* which are in accordance with STAS 91-83.

The bread was well done, the shape was a correct one, without deformation, crumb didn`t have cracks. The inside was well done, with proper porosity, not wet. The color of the crumb was uniform, golden, darker than the witness, without dark spots. The taste and the smell were pleasant, more intense for the bread with 70% potatoes paste addition.

3.2. Potatoes paste supplemented bread physic-chemical evaluation

The bread obtained according to the *paragraph 2.1.*, showed the following physic-chemical features *(table 3)* which are in accordance with *STAS 91-83.*

Centralizing the obtained data, it may be said that, in all cases in which potatoes paste was added, the obtained products were proportional, specific to the assortment, the volume-visually appreciated - was higher than the witness sample volume, the products were not excessively flattened or curved.

Table 1. Sensorial characteristics evaluation of bread with potatoes paste addition through points scale method

Product characteristics	**Points**			
	Witness	**Bread with 30% potatoes paste addition**	**Bread with 50% potatoes paste addition**	**Bread with 70% potatoes paste addition**
Form, exterior aspect, volum	2	2.5	4	3
Crumb aspect	1.5	2	3	2.5
Consistency and chewing comparisson	1.5	2	3	2.5
Bread aspect	1.5	2.5	3	2
Smell	2	2.5	3	1
Taste	2	2.5	3	1
Points	**10.5**	**14**	**18**	**12**

After the examination the products took the following qualifications:

Table 2. Qualifications for bread with potatoes paste addition

Sample	**Points**	**Qualification**
Witness	10.5	Satisfactory
Bread with 30% potatoes paste addition	14	Good
Bread with 50% potatoes paste addition	18	Very good
Bread with 70% potatoes paste addition	12	Good

Table 3. Potatoes paste supplemented bread physic-chemical features

Analyzed physic-chemical features	**Witness (S1)**	**Bread with 30% potatoes paste addition**	**Bread with 50% potatoes paste addition**	**Bread with 70% potatoes paste addition**
Product volume (cm^3/100 g product)	275	278	282	270
Crumb porosity (% volume)	70.8	72.2	75.7	67.9
Crumb elasticity (%)	95.4	96.1	96.9	92.4
Diameter/height ratio (cm)	0.466	0.486	0.502	0.427
Product moisture (%)	27.65	31.26	34.46	37.76
Product acidity (acidity degrees/100g product)	0.49	0.51	0.71	0.92

Table 4. Potatoes paste content influence on Young modulus for the obtained bread assortments

Assortment (% potatoes paste)	**Sample number**	**Young modulus (Pa)**	**Young modulus Average value (Pa)**
0	1	16550 ± 110	15290 ± 90
	2	14020 ± 70	
30	1	17020 ± 140	17070 ± 120
	2	17120 ± 110	
50	1	12970 ± 90	12000 ± 70
	2	11040 ± 50	
70	1	18380 ± 100	18140 ± 100
	2	17900 ± 100	

Figure 1. Sorts of bread produced

If the values for H/D ratio are between 0.4-0.5 then the volume and the form of bread are considered good ones, over 0.5 the bread is too high, and under 0.4 the bread is too flat.

It can be seen that, upon potatoes paste addition, the bread volume rised; thus, for upon a 50% potatoes paste addition, H/D ratio ranges in the limitation of STAS.

Analyzing the porosity it was determined that for 50% the pores aspect was maintained. From table 3 it could be observed that the volume of samples was higher than the witness except the sample with 70% potatoes paste addition. Also, for samples with 30% and 50% potatoes paste addition the porosity was more accentuated and the elasticity better, and crumb was darker because of the Maillard compounds formed during baking. For 70% potatoes paste addition sample, the porosity and the elasticity were reduced by the bigger potatoes content and smallest flour content and those smaller gluten content.

The moisture of all samples with potatoes paste addition was higher than the witness, between 27.65% (witness) and 37.76% (bread with 70% potatoes paste addition). This increase was because on the one hand of the water from potatoes paste and on the other hand of the colloidal processes (the coagulation of proteic substances and starch jellification) from baking.

The acidity of samples with potatoes addition was higher than witness, varying between 0.49 (witness) to 0.92 (bread with 70% potatoes paste addition) because of the presence of the organic acids.

Looses after baking process of bread with potatoes paste addition in proportion of 30%, 50% and 70% varied between 13.8% and 16.9% and just 11.9% for the blank sample.

Experimental data obtained for sensorial and physical- chemical analysis for bread with potatoes added suggested that this addition could be used in bakery process. *Figure 1* presents types of bread obtained as *paragraph 2.1.*

*3.3. Bread rheological features evaluation.*The bread assortments with different amounts of potato paste addition (30%, 50%, 70%) were submitted to compression tests. As follows, the tests applied on the various bread assortments, are presented. Experimentally, for the compression, the dependence F =f(t) was obtained. in order to calculate the rheological features of the potato supplemented bread, this dependence was transformed into τ =f(ε) [1,4,14].

The graphical τ =f(ε) is not a linear dependence, but in the small deformations domain, the dependence is linear, and from its slope, the compression modulus was calculated [1,4,19,21].

The experimental compression curves and linear specific deformation upon which, sample ruptures are initiated, respectively, for the witness bread samples and bread samples with 30%, 50% and 70% potato paste addition, compressed with a constant speed to γ_c = 0,4 - 0,6 , are shown in *figures 2-5*. For the same bread assortments, *table 4* presents the values of the compression modulus, values calculated from the compression curves.

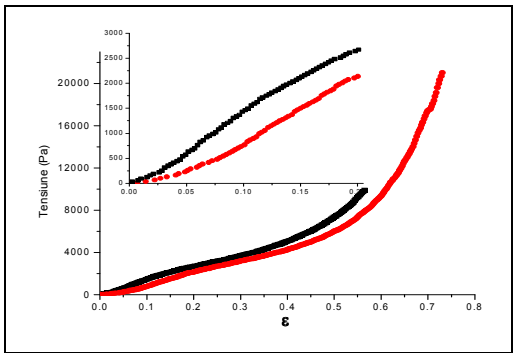

Figure 2. Compression curves for the witness bread (without potatoes paste) (■ sample 1; ● – sample 2)

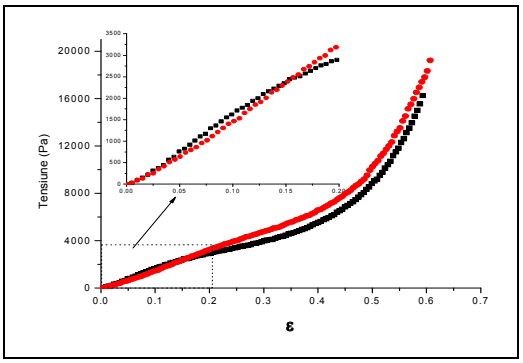

Figure 3. Compression curves for the 30% potatoes paste supplemented bread (■sample 1; ● – sample 2)

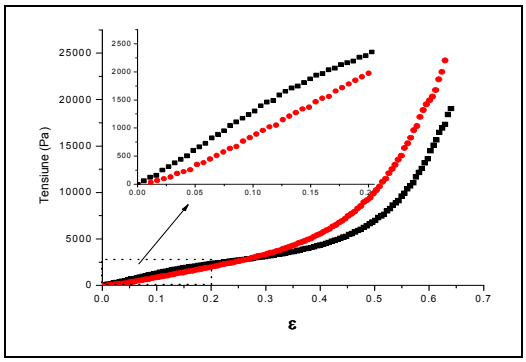

Figure 4. Compression curves for the 50% potatoes paste supplemented bread (■sample 1; ● – sample 2)

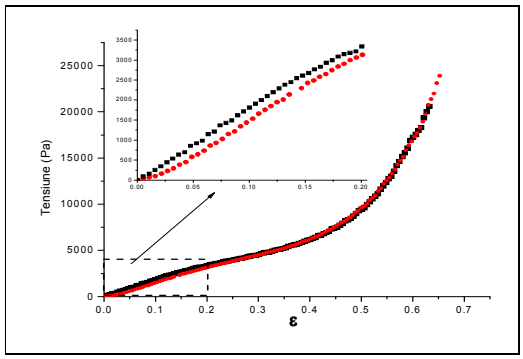

Figure 5. Compression curves for the 70% potatoes paste supplemented bread (■-sample 1; ● –sample 2)

It can be seen from *figures 2-5,* a sigmoid dependence for $\tau = f(\varepsilon)$, for all bread assortments. The first part of the sigmoid for $\varepsilon < 0.2$ may be a result of the elastic compression of the bread crumb. On this portion that is for small deformations the bread crumb behaves as an elastic material with spongy structure (like a sponge). Having in view these specifications, the compression modulus of the bread crumb for the tested assortment, was calculated from the slope of this portion approximated as linear.

Also, from *table 4* it can be seen that, the 50% potato paste supplemented bread has the lowest compression modulus, which means that this bread assortment is the most elastic. The second portion, more flattened, situated around values $\varepsilon \in (0.2 - 0.5)$, corresponds to the compression domain, in which ruptures of the gas bubbles walls from inside the bread crumb appear. The start of this portion corresponds to the breaking point, which has the coordinates ε_r and τ_r. The ε_r values from *figure 4,* suggest also, that the samples with 50% potato paste have the highest elasticity, because the first ruptures into the bubbles walls, appear at $\varepsilon_r \cong 0.23$.

Also, from *figure 4,* it can be seen that, for $\varepsilon = 0.15$, the compression tension necessary for reaching this deformation, is around 12000 Pa, for the 50% potato paste supplemented bread. This is an extra proof of the special elasticity given by the potato paste, to the bread crumb.

On the last portion of the sigmoid, corresponding to a value $\varepsilon > 0.5$, a high increase of the slope value can be noticed. This portion may be a result of the sample compression, from which all the gas bubbles were removed.

Regarding the potatoes paste homogeneity from the bread dough, according to *figures 3-5,* it can be seen that in the 70% potato paste supplemented bread, this was the best included into the dough upon kneading. Having in view that, kneading was performed manually, and the 70% addition was better made uniform into the dough, it is recommended that, in the case other ingredients addition, other than the basic ones, the kneading must be performed mechanized, for a better homogenization inside the dough.

Thus, it is observed the influence that the potato content has on the overall rheological studied features. The dependence between the compression modulus and the potatoes content, from *figure 6,* emphasize that a 50% potatoes content (the lowest Young modulus value is 12000 Pa), provides the best elasticity for the bread crumb.

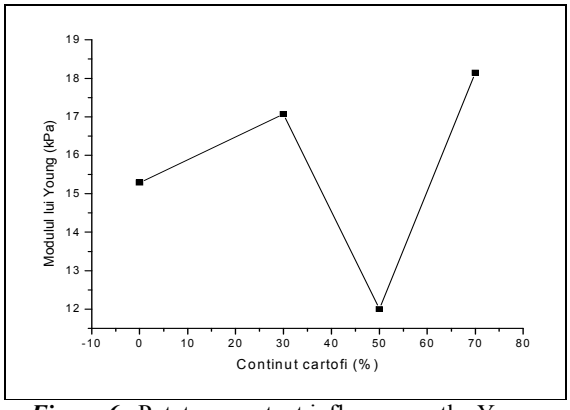

Figure 6. Potatoes content influence on the Young modulus value for the studied bread

4. Conclusions

By potatoes supplement in the bread obtained with the classical method, results a bread assortment with high nutritional value as a result of the carbohydrates, proteins, vitamins and mineral salts contribution brought by these.

Additionally, beside improving the processing features, the advantages of potato addition, as a secondary helping ingredient of the bread, are: rising the bread volume, improving the crumb structure and increasing the shelf life of bread , as a result of the natural sugars and organic acids content.

Also, 50% potato paste addition has the best influence on the dough rheological features improves the elastic properties of the bread crumb.

Thus, the experimental data suggest that potato paste addition can be successfully used in bakery.

Also, using potatoes pasta in bread dough could be substituted a quantity of flour from total height and total gluten content decreases. For this reason bread with potatoes is recommended for those with low tolerance on gluten.

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